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Effect of stocking density on the production of common carp (*Cyprinus carpio* Lin.) in cages at Kaptai lake, Bangladesh

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Abstract
Growth, survival and food conversion ratio (FCR) of *Cyprinus carpio* in cages at different stocking density were studied in Kaptai lake. Fingerlings of common carp (12.47 ± 4.29 g) were stocked at $25/m^2$, $50/m^2$ and $75/m^2$ each with replication in six floating net cages each of 5m x 5m x 4m and reared for 240 days. The growth rate was inversely related to the stocking density with the mean weights of 325.5 ± 11.74 g, 268.99± 8.44 g and 167.0 ± 11.66 g at low, medium and high densities, respectively. At harvest, standing crop biomass averaged 7.82, 12.83 and 11.58 kg with the survival of 98.9%, 97.6% and 94.4% and food conversion ratios of 4.51, 3.82 and 4.21 for the above three densities, respectively. Weight gain and production at density 25 fish/m^2 were significantly different ($p< 0.01$) from other two densities. Water quality was not affected in the cages having different stocking densities.
Key words: Stocking density, Common carp, Kapai lake

Introduction

Kaptai reservoir with an average surface area of 58,300 ha constitute a largest man-made lake in Bangladesh and also in the whole of South East Asia (Fernando 1980). However, it was constructed by damming the Karnafuli river primarily for hydroelectric power generation and as well as for navigation, flood control and irrigation purposes, but its contribution to the fish production can not be neglected. Even this potentiality could be increased several fold by adopting cage culture technique. Additional advantages of this technique are that it could avoid the tedious task of aquatic weeds and predator control. Today in many countries fish production in cages has extensively developed by the improvement of stocking rates, feeding methods and selection of species (Sodikin 1977). The present study on monoculture of common carp in cages were undertaken to determine a suitable stocking rate by administering different indigenous components which can yield optimum growth in reasonably short period. The dearth of published information in this line has been presented by Jangkuru and Djajadiredja (1979), Backiel *et al.* (1984), Haque *et al.* (1984) and Costa-Pierce *et al.* (1989).

Material and methods

Six floating net cages each of 5m x 5m x 4m have been constructed with knotless polyester net (meshing 10.5 mm) and fitted to the inner side of a bamboo frame. The whole structure was kept afloat by means of empty plastic oil drum fastened at reasonable distance by synthetic ropes. A separate synthetic net to prevent the escape of the fish closed upper side of each net. Two bamboo made feeding baskets were hung loosely 1m below the surface water in each cage with the help of nylon twine. Thereafter, all these cages were stocked with fishes of 12.47±4.29g in average body weight at the rate of 25 (cage 1 and 2), 50 (cage 3 and 4) and 75 (cage 5 and 6) fish/ m^2 and continued rearing up to 240 days to observe their growth rate.

Supplementary feed composed of 30.2% dietary protein; extracted from 20% fish meal, 20% rice bran, 40% mustard oil cake and 20% wheat bran was fed to the fish at 5% body weight twice daily. After each 30 days interval, 20% fish from each cage were caught, measured and weighed as a group. Subsequently feeding rates were adjusted according to new biomass. At the end of 240 days of rearing all the fishes were harvested, counted and weighed .

Consequently, water temperature, dissolved oxygen, free carbondioxide, pH and total alkalinity of water within the cages were measured fortnightly between 9 to 10 am by using the centigrade thermometer, winkler method (APHA 1981), phenolphthalein indicator method, lovibond disk comparator and titrimetric method, respectively.

Results and discussion

Data for stocking, survival and growth ratios as well as the food conversion ratio (FCR) are given in Table 1. Growth patterns are shown in Fig. 1. The survival rates were 98.9%, 97.6% and 94.4% at low, medium and high densities, respectively. Simultaneously, within 240 days the mean weight of *C. carpio* attained 325.5± 11.74 g with an average daily growth of 1.3 g fish/ day, 268.99 ± 8.44 g with an average daily growth 1.1 g fish/day , and 167.0 ± 11.66 g with an average daily growth of 0.6 g fish/day i.e., the total increase in weight was 2550%, 2057% and 1239 % in the above three densities, respectively. These in term of yields in three stocking rates were 7.82 kg /m^2 , 12.83 kg/m^2 and 11.58 kg/m^2 (Table 1). FCR ratios in three sets of replicated cages with increasing densities were 4.51, 3.82 and 4.21, respectively.

Statistical analysis about the individual growth also support in favour of 25 fish/m^2 ($p< 0.01$) than that of 50 fish/m^2 and 75 fish/m^2. This is probably due to low stocking rate, sufficient natural food and space as well as less competition prevailed in the condition. Lembi *et al.* (1968) and Kilambi *et al.* (1977) reported that decreasing in individual growth with increasing stocking density might be due to heavy competition during feeding at densely populated cages.

Again, the total production of fish at the end of the experimental period was maximum in 50 fish/m^2 cages (Table 1) and next to this was in 75 fish/m^2 cages. Production at 25 fish/m^2 was significantly different ($p< 0.01$) from other two densities.

Table 1. Growth performance of common carp (*Cyprinus carpio*) within 240 days of experiment at three stocking densities of Kaptai lake

Cage no.	No of fish stocked	Mean weight in (g) at stocking	Mean weight in (g) at harvest	Net gain (g)	Total increase in weight (%)	Average daily growth (g) fish/ ay	Survival rate (%)	FCR	Yield/month (kg)
1	500	12.47±4.29	332.0±13.30	319.53A	2562	1.331	98.2	4.83	7.988A
2	500	12.47±4.29	319.0±10.18	306.53A	2458	1.277	99.6	4.20	7.663A
3	1000	12.47±4.29	261.9±8.37	249.43BC	2000	1.039	97.8	3.55	12.471BC
4	1000	12.47±4.29	276.09±8.04	263.62BC	2114	1.098	97.4	4.09	13.181BC
5	1500	12.47±4.29	173.09±10.82	160.62BD	1288	0.669	94.7	4.32	12.046BC
6	1500	12.47±4.29	160.91±12.50	148.44BD	1190	0.618	94.0	4.11	11.113BC

Value representing same superscript vertically do not differ significantly (P< 0.01).

Dimitrov (1976) said that the best production of carps in net cages achieved at higher stocking densities (80 and 50 fish/m^2) than the lower one (25 fish/m^2). Backiel and Le Cren (1967) found that the growth and production of fish are to certain extent, dependent on the population density. Powell (1972) mentioned the harmful effects of at higher stocking density on the culture of fish were reduction of growth rate, increase of food conversion ratio and lowering of survival rate. Higher survival rate in the present study was obtained in low stocking density cages.

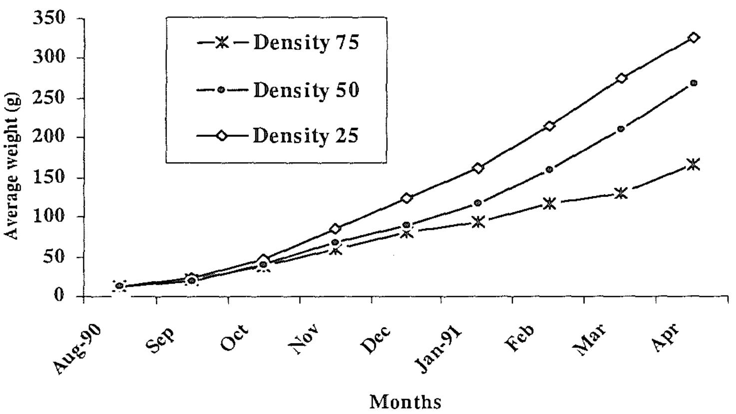

Fig. 1. Growth curves of *Cyprinus carpio* stocked at three different densities in cage at Kaptai lake.

An average daily growth at three densities might be compared with the growth of 1.4 g for 25 g *O. spilurusniger* (Gunther and Haller 1974), 1.0-3.0 g for 50 g tilapia (Marek 1975), 0.85 g for 20 g tilapia (Hastings 1973) and 0.58 g for 25 g *Oreocromis niloticus* in ponds (Miller 1976) .

Ćosta-Pierce *et al.* (1989) reported the mean weight of common carp attained 500g within 3-4 months with an average production of 12.83 kg/m^2 at density of 50 fish/m^2 also support in term of yield for medium density. They also found a very healthy condition of fish with 97.6 % survival rate. The water quality had not deteriorated and a higher production was possible by increasing the stocking density up to 50 fish/m^2 .

Different stocking densities had influenced the food conversion efficiencies (Table 1). The FCR ratio varies from species to species, for different types of foods and in different environments. For *O. niloticus*, Hepher and Pruginin (1982) reported FCR values of 3.6 for ground nut cake, 4.8 for cotton seed cake, 1.8 to 6.5 for pelleted chicken feed plus 10% fresh fish, 12.6 for brewery waste and 18.9 for cotton seed crush. Shell (1968) reported an FCR value of 2.31 for *O. niloticus* feed consisting 25% dietary protein rich pelleted feed. Allison *et al.* (1976) reported food conversion ratios of 1.56, 1.40, 1.27 and 0.92 in four concrete tanks for *O. aureus* stocked at different densities and found that higher rates of stocking affected the water quality and food conversion efficiency.

Monthly average water temperature in cages ranged from 22.5 (January) to 31.0 (April). Water pH ranged from 7.5 to 8.5. A pH of 7-8 has been recommended as the best pH for fish culture (Huet 1972). Average morning concentrations of DO ranged from 5.8 to 8.2 mg /l (Fig. 2) which is very suitable for any aquatic life (Boyd 1979). Free CO_2 ranged from 4.4 to 6.0 mg/1 and total alkalinity from 44.0 to 56.0 mg/l^1 (Fig. 2). The alkalinity of water of cages does not have a direct effect on fish but an alkalinity between 30 and 200 mg/l^1 has been recommended for freshwater fish culture (Stickney 1979). Therefore, water temperature, pH, DO, free CO_2 and total alkalinity were within optimum ranges for carp growth. Water quality was not affected in the cages having different stocking densities (Fig. 2). The data suggest that rearing of common carp at a density more then 50/m^2 will not be effective at the management level described in the present study.

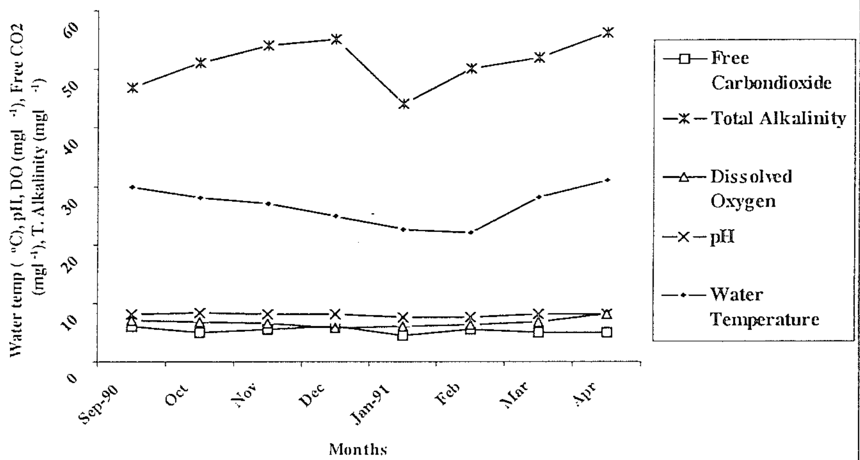

Fig. 2. Water temperature). pH. dissolved oxygen, free carbondioxide and total alkalinity of cage water at Kaptai lake.

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